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INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED	
PCT/DE00/00733	March 9, 2000	March 9, 1999	

TITLE OF INVENTION

METHOD FOR IMPLICITLY PROJECTING COMMUNICATIONS LINKS

APPLICANT(S) FOR DO/EO/US

BECKER, Norbert; DIEZEL, Matthias; ECKARDT, Dieter; LANGKAFEL, Dirk; LANGE, Ronald;
WINDL, Helmut; BIEHLER, Georg; DONNER, Albrecht; KRAEMER, Manfred; LEINS, Ralf;
SCHNIEDER, Karsten

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39 (1).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau). WO 00/54146
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is transmitted herewith.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4)
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 20. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98-1449 and International Search Report (PCT/ISA/210) w/ 2 documents
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☒ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:
 - 1.) Three (3) sheets of Formal Drawings
 - 2.) PCT Substitute Claims Letter w/ amendments

/cqc

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Norbert BECKER, Matthias DIEZEL, Dr. Dieter ECKARDT, Dick LANGKAFEL, Ronald LANGE, Helmut WINDL, Georg BIEHLER, Dr. Albrecht DONNER, Manfred KRAEMER, Ralf LEINS, and Karsten SCHNEIDER

Application No.: NEW

Filed: September 7, 2001

For: METHOD FOR IMPLICITLY PROJECTING COMMUNICATIONS LINKS

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

September 7, 2001

Sir:

The following preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE ABSTRACT

Please replace the Abstract with the attached revised Abstract.

IN THE SPECIFICATION

Please replace the original specification with the Substitute Specification attached hereto.

IN THE CLAIMS

Please replace the original claims with the following new claims:

1. (Amended) A method for projecting communications relationships within automation solutions comprising:

creating an automation solution using an engineering system by using automation objects;

connecting an output of an automation object to an input of an another automation object, an interconnection for a data source administering a reference to the corresponding output of an automation module, and an interconnection for a data sink administering a reference to the corresponding input of an automation module; and

assigning, after creating an automation solution, the automation objects to physical equipment units of a system, wherein interconnections represent intra-equipment unit communications relationships and wherein communications relationships within an equipment unit is only determined as a result of the assigning.

2. (Amended) The method as claimed in claim 1, wherein the interconnections are assignable with a quality of service wherein specific properties, which are to be fulfilled, are definable for the communications relationships.

3. (Amended) The method as claimed in claim 1, wherein a projected automated solution is downloaded into the system, the download being carried out for each equipment-unit representative in the projection environment, and wherein each equipment-unit representative is able to communicate with the physical equipment unit in the system via a communications link.

4. (Amended) The method as claimed in claim 3, wherein, in a first step of the download, corresponding run time automation objects in the physical equipment unit are generated for each equipment-unit representative for assigned automation objects, and wherein the communications links described by the interconnections are established in a second step.

5. (Amended) The method as claimed in claim 3, wherein the interconnections are enhanced with information relating to the system, addressing of the source and sink of a communications relationship being expanded with identifiers

- of the physical equipment unit,
- of the run time automation objects and
- of the inputs and outputs of the run time automation objects.

6. (Amended) The method as claimed in claim 3, wherein each equipment-unit representative communicates to its physical counterpart via the enhanced interconnections of its automation objects and wherein each equipment unit establishes its internal and external communications relationships on the basis of the interconnection information.

7. (Amended) The method as claimed in claim 3, wherein each equipment unit establishes only the communications relationships in which it functions as a source.

8. (Amended) The method as claimed in claim 1, wherein setting up of an interconnection does not cause any changes in the automation objects.

9. (Amended) The method as claimed in claim 1, wherein the equipment-unit representatives in the projection environment satisfy a uniform equipment unit model and form an abstraction of the real equipment units.

Please add the following new claims:

-- 10. The method as claimed in claim 2, wherein a projected automated solution is downloaded into the system, the download being carried out for each equipment-unit representative in the projection environment, and wherein each equipment-unit representative is able to communicate with the physical equipment unit in the system via a communications link.

11. The method as claimed in claim 4, wherein the interconnections are enhanced with information relating to the system, addressing of the source and sink of a communications relationship being expanded with identifiers

- of the physical equipment unit,
- of the run time automation objects and
- of the inputs and outputs of the run time automation objects.

12. The method as claimed in claim 10, wherein the interconnections are enhanced with information relating to the system, addressing of the source and sink of a communications relationship being expanded with identifiers

- of the physical equipment unit,
- of the run time automation objects and
- of the inputs and outputs of the run time automation objects.

13. The method as claimed in claim 10, wherein each equipment-unit representative communicates to its physical counterpart via the enhanced interconnections of its automation objects and wherein each equipment unit establishes its internal and external communications relationships on the basis of the interconnection information.

14. The method as claimed in claim 4, wherein each equipment-unit representative communicates to its physical counterpart via the enhanced interconnections of its automation objects and wherein each equipment unit establishes its internal and external communications relationships on the basis of the interconnection information.

15. The method as claimed in claim 5, wherein each equipment-unit representative communicates to its physical counterpart via the enhanced interconnections of its automation objects and wherein each equipment unit establishes its internal and external communications relationships on the basis of the interconnection information.

16. The method as claimed in claim 12, wherein each equipment-unit representative communicates to its physical counterpart via the enhanced interconnections of its automation objects and wherein each equipment unit establishes its internal and external communications relationships on the basis of the interconnection information.

17. The method as claimed in claim 3, wherein each equipment unit establishes only the communications relationships in which it functions as a sink.

18. The method as claimed in claim 4, wherein each equipment unit establishes only the communications relationships in which it functions as a source.

19. The method as claimed in claim 4, wherein each equipment unit establishes only the communications relationships in which it functions as a sink.

20. The method as claimed in claim 5, wherein each equipment unit establishes only the communications relationships in which it functions as a source. --

REMARKS

Claims 1-20 are now present in this application, with new claims 10-20 being added by the present Preliminary Amendment. It should be noted that the amendments to original claims 1-10 of the present application are non-narrowing amendments, made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations. For example, amendments have been made to broaden the claims; to remove reference numerals in the claims; remove the European phrase "characterized in that"; remove multiple dependencies in the claims; and to place claims in a more recognizable U.S. form, including the use of the transitional phrase "comprising" as well as the phrase "wherein". Other such non-narrowing amendments include reorganizing method claims (separate clauses beginning with "-ing" verbs) in a more recognizable U.S. form. Again, all amendments are non-narrowing and have been made solely to place the claims in proper form for U.S. practice and not to overcome any prior art or for any other statutory considerations.

SUBSTITUTE SPECIFICATION

In accordance with 37 C.F.R. §1.125, a substitute specification has been included in lieu of substitute paragraphs in connection with the present Preliminary Amendment. The substitute specification is submitted in clean form, attached hereto, and is accompanied by a marked-up version showing the changes made to the original specification. The changes have been made in an effort to place the specification in better form for U.S. practice. No new matter has been added by these changes to the specification. Further, the substitute specification includes

paragraph numbers to facilitate amendment practice as requested by the U.S. Patent and Trademark Office.

CONCLUSION

Accordingly, in view of the above amendments and remarks, an early indication of the allowability of each of claims 1-20 in connection with the present application is earnestly solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Donald J. Daley at the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By: 

Donald J. Daley, Reg. No. 34,313

DJD:kna

P.O. Box 747
Falls Church, VA 22040-0747
(703) 205-8000

ABSTRACT OF THE DISCLOSURE

A method provides for implicitly projecting communications links. The projection of the communications links is carried out by interconnecting the automation objects, and setting the quality of service (QoS) of the communications relationships. Thereafter, the automation objects are assigned to equipment units. Finally, the automation solution is downloaded into the system.

MARKED - UP - VERSION OF THE SPECIFICATION
- 1 -

Description

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JC12 Rec'd PCT/PTO 07 SEP 2001

PCT 9
Method for implicitly projecting communications links

- FIELD OF THE INVENTION*
- 5 The invention relates to a method for implicitly projecting communications links.

BACKGROUND OF THE INVENTION

Such a method is used in particular in the field of automation technology. An automation solution is generally composed of a multiplicity of individual automation objects which frequently have a high degree of dependency of the automation object on the respectively used engineering system. The result of this is that automation objects of a manufacturer frequently require a specific engineering system and cannot be used in other systems with automation objects of other manufacturers.

THE SPECIALIST ARTICLES

20 The specialist articles Zinky, J. A. et al: "Architectural Support for Quality of Service for CORBA Objects", Theory and Practice of Object Systems, (Online) Vol. 3, No. 1, 1997, pages 55-73, XP000961779, Wiley, USA, ISSN: 1074-3227 describes a system architecture (Quality of Service) for CORBA objects.

25 The described architecture was developed in particular with the objective of simplifying the implementation of and use of objects distributed in a long-distance traffic network.

SUMMARY OF THE INVENTION

30 The invention is based on the object of permitting communications links to be projected within automation solutions, in particular without restriction to boundaries between equipment units.

and for other objects are

35 This object is achieved by means of a method having the features disclosed in claim 1.

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- The invention is based on the knowledge that previous solutions have a series of disadvantages. The automation objects used in creating the automation solution have inputs and outputs via which they can
- 5 communicate with other automation objects. These inputs and outputs are used to determine, at the projection time, which communication has to take place at the run time of the automation solution.
- 10 In existing projection systems, the projection of the communication takes place per equipment unit. Within one equipment unit, communication relationships between the automation

objects of the equipment unit are established by what is referred to as interconnections. An interconnection connects an output of an automation object to an input of an automation object in the engineering process and thus determines the communication which takes place at the run time. If communication between equipment units is necessary, it must be projected by means of special communication modules.

This solution has the following disadvantages:

- 10 • **explicit projection of the communication:** communication between equipment units must be explicitly projected. To do this, suitable communication modules must be selected. These must then be appropriately parameterized and
15 interconnected with the actual automation objects.
- **determination of the equipment units before the automation solution is created:** before the development of the automation solution can be started, it is firstly necessary to determine which equipment units
20 will later run the projected solution. Only then can the development of the solution be started, in each case on one equipment unit.
- **costly change to the assignment of equipment units:** if an equipment unit is selected, the automation
25 objects which are projected onto it cannot be readily transferred to another equipment unit.
- **determination of the communication protocols:** the use of specific communications modules automatically imposes a restriction to the specific communication
30 protocols.

In the solution according to the invention, the automation solution in the engineering process is composed successively by the use of automation objects.

- 35 The automation objects are a number of modules which have a specific functionality. The automation objects have inputs and outputs which can be used to predetermine values for the calculations or the result of the calculations can be picked up.

The automation solution is actually created by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the communication which takes place on the system during the run time. The communication can have any desired content. It can comprise, for example, data or events. In the following image, the indications between the inputs and outputs of the automation objects A01, A02, A03 and A04 are represented by lines.

An interconnection is an independent object which unambiguously determines a communication relationship between two automation objects. To do this, a reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not bring about any changes in the interconnected automation objects.

Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit and intra-equipment unit communication is eliminated here.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described and explained in more detail below with reference to the exemplary embodiments illustrated in the figures, in which

Figure 1 shows a basic diagram of a projection by means of interconnections,

Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)",

Figure 3 shows an exemplary embodiment of an assignment of automation objects to equipment units, and

Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a basic diagram of a projection by means of interconnections. In the engineering process, the automation solution is composed successively by using automation objects. The automation objects are a type of module which have a specific functionality. The automation objects have inputs and outputs which can be used to predefine values for the calculations and/or to pick up the result of the calculations.

The actual creation of the automation solution is carried out by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the communication which takes place for the run time on the system. The communication can have any desired content. It can comprise, for example, data or events. In the following image, the interconnections between the inputs and outputs of the automation objects A01, A02, A03 and A04 are represented by lines.

An interconnection is an independent object which unambiguously defines a communication relationship between two automation objects. To do this, the reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not result in any changes in the interconnected automation objects. Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit

and intra-equipment unit communication is eliminated here.

Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)". The quality of service of the communications relationship can be additionally set for the established
5 interconnections. One example is the setting of the cycle time with which changes are checked at the data source. If the cycle time is relatively long, this means that relatively little communication takes place between the automation objects. For this reason,
10 distribution among various equipment units is rather uncritical because the generated network load is low.

A cycle time of 20 milliseconds is set for the interconnection between automation objects AO2 and AO3
15 in Figure 2.

Figure 3 shows an exemplary embodiment of an assignment of the automation objects to equipment units. After the automation solution has been created, the automation
20 objects are assigned to equipment units. The equipment units are representatives of real equipment units of the system (such as memory-programmable controllers or drives) in the projection environment. The projection of the equipment units and of the associated networks
25 is carried out separately. The representatives of the equipment units in the projection environment satisfy here a uniform equipment unit model and thus form an abstraction of the real equipment units.

30 For each automation object, it is then determined which equipment unit the automation object will later be executed on in the system. In a graphic editor, this can be implemented by means of drag and drop, for example. Which interconnections represent intra-
35 equipment unit communication and which represent communication which is internal to an equipment unit, is only determined as a result of the assignment. In Figure 3, the result of the assignment of the automation objects AO1 and AO2 to G1 and AO3 and AO4 to

G2 is that the communication between A01 and A02 and also between A03 and A04 is internal to an equipment unit, while the

communication between AO1 and AO3 and as well as between AO2 and AO4 is intra-equipment unit communication.

- 5 In an effective implementation of the assignment, the data of the equipment units (and networks) and of the respective predefined quality of services can be used in order to carry out a first plausibility check of the respective real-time requirements made of the
10 automation solution.

Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system. The automation solution which has so far been projected
15 is downloaded into the real system in the last step. This procedure is designated as a download. The download is initiated from the projection environment and is carried out for each equipment unit, to be more precise the representatives of the equipment unit, in
20 the production environment. Each equipment-unit representative knows its real counterpart in the system and can communicate with it via the communication link of the projection environment to the system. In the first step, the automation objects assigned to each
25 equipment-unit representative are generated for ~~said~~ ^{the} representatives ~~thence~~ the corresponding counterparts in the physical equipment unit. In the case of a freely programmable equipment unit, this means that a corresponding piece of code is downloaded into the
30 equipment unit. For an equipment unit with a fixed functionality, the corresponding run time counterpart of the automation object in the physical equipment unit is identified. In the second step, the communications relationships described by the interconnections are
35 established. Here, the addressing of the source and sink of a communications relationship is expanded with corresponding identifiers of the inputs and outputs of the run time automation objects. Such an identifier is composed of the identifiers of the physical equipment

unit, of the run time automation object and of the input and output. A common equipment unit model of the run time environment is necessary for this. Each equipment unit representative then communicates to its

5 physical counterpart the enhanced interconnections

of its automation objects. On the basis of the interconnection information, each equipment unit then establishes its internal and external communications relationships. The enhanced information of the interconnections is used to do this. In an efficient implementation, use can be made of the fact that each equipment unit has to establish only the communications relationships in which it functions as a source (or alternatively as a sink).

In our example, the automation objects AO1 and AO2 are established on the equipment unit physical RG1 as run time automation objects RAO1 and RAO2 and AO3 and AO4 on the equipment unit RG2 as RAO3 and RAO4. The interconnection information is then enhanced, as described, with corresponding information on the run time environment. For the communications relationship between AO1 and AO3, this information comprises the identifiers of RG1, RAO1, of the output of RAO1 for the source and RG2, RAO3, and the input of RAO3 for the sink. This information can then be used to set up the corresponding communications relationship between RAO1 on the equipment unit RG1 and RAO3 on the equipment unit RG2.

The development of the automation functionality is dissociated from the automation equipment units to be used. As a result, a distinction is no longer made between the projection of communication between automation objects within an equipment unit and projection onto different equipment units. In the case of intra-equipment unit communication, it is necessary to ensure here that the real-time requirements of the application are complied with. Communications relationships between automation objects are projected uniformly by means of interconnections. The interconnections can be assigned a specific quality of service by means of which specific properties which are to be fulfilled can be determined for the communications relationship. In particular, in the case

of an intra-equipment unit communications relationship,
the quality of service can be used in order to test
whether the communications relationship

can be set up (and ensured) by the equipment units in question.

but is not limited to

This approach provides the following advantages:

- 5 • **uniform projection by means of interconnection:** the projection of the communication between automation objects is carried out in a uniform fashion. The case of intra-equipment unit communication no longer has to be handled separately. Furthermore, the
10 projection can take place independently of the communication content (for example data or events).
- **less outlay on projection:** in the case of intra-equipment unit projection, the use and projection of special communications modules is eliminated.
- 15 • **more flexible assignment of equipment units:** automation objects can now be assigned to an equipment unit at any time, and/or the assignment can easily be changed.
- **ease of change:** the explicit procedure of assigning
20 automation objects to equipment units simplifies the use of other target systems/bus systems significantly.

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Marked-up - version of the claims

Patent claims

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1. A method for projecting communications relationships within automation solutions [in particular without restriction to boundaries between equipment units, in which] ~~comprising~~

~~an~~ automation solution [is composed] using an engineering system by using automation objects [A01, A02, A03, A04], ~~comprising~~

10 [in each case one interconnection connects] an output of an automation object [A01, A02, A03, A04] to an input of an another automation object [A01, A02, A03, A04], ~~the~~ interconnection for a data source administering a reference to the corresponding output of an automation module [A01, A02, A03, A04], ~~and a reference to the corresponding input of an automation module [A01, A02, A03, A04] for a data sink, and~~

~~after the creation of the~~ automation solution, the automation objects [A01, A02, A03, A04] are assigned to physical equipment units [RG1, RG2] of a [real] system, [and which] interconnections represent intra-equipment unit communications relationships and [which represent] communications relationships within an equipment unit is only determined as a result of the [assignment]. ~~assignment~~

2. The method as claimed in claim 1, characterized in that ~~the~~ interconnections ~~can be assigned~~ a quality of service [by means of which] ~~where~~ specific properties, which are to be fulfilled, ~~can be defined for the~~ communications relationships. ~~one assignable unit~~

3. The method as claimed in claim 1 [or 2], characterized in that ~~the~~ projected automated solution is downloaded [by means of a download] into the [real] system [by means of a download] the download being

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carried out for each equipment-unit representative (G1,
G2) in the projection environment, and ^{each} each

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- 10 -

equipment-unit representative (G1, G2) being able to communicate with the physical equipment unit (RG1, RG2) in the system via a communications link.

5 4. The method as claimed in claim 3,
wherein, in the first step of the download, the
corresponding run time automation objects (RAO1, RAO2,
RAO3, RAO4) in the physical equipment unit (RG1, RG2)
are generated for each equipment-unit representative
10 (G1, G2) for the automation objects (AO1, AO2, AO3,
AO4) which are assigned to it, and the communications
links described by the interconnections are established
in the second step.

15 5. The method as claimed in claim 3 or 4,
(characterized in that) the interconnections are enhanced
with information relating to the real system,
addressing of the source and sink of a communications
relationship being expanded with identifiers
20 - of the physical equipment unit (RG1, RG2),
- of the run time automation objects (RAO1, RAO2,
RAO3, RAO4) and
- of the inputs and outputs of the run time automation
objects (RAO1, RAO2, RAO3, RAO4).

25 6. The method as claimed in one of claims 3 to 5,
(characterized in that) each equipment-unit
representative (G1, G2) communicates to its physical
counterpart (RG1, RG2) the enhanced interconnections of
30 its automation objects (AO1, AO2, AO3, AO4) and each
equipment unit (RG1, RG2) establishes its internal and
external communications relationships on the basis of
the interconnection information.

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7. The method as claimed in ^{claim} one of claims 3 to 6,
characterized in that ^{idea} each equipment unit (G1, G2)
establishes only the communications relationships in
which it functions as a source [or alternatively as a
5 sink].

8. The method as claimed in ^{claim 1} one of the preceding
claims,
characterized in that the ^{vision} setting up of an
10 interconnection does not cause any changes in the
automation objects (AO1, AO2, AO3, AO4).

9. The method as claimed in ^{claim 1} one of the preceding
claims,
15 characterized in that ^{wherein} the equipment-unit
representatives (G1, G2) in the projection environment
satisfy a uniform equipment unit model and form an
abstraction of the real equipment units (RG1, RG2).

NEW

10. same as 3, but dep on 2
11. same as 5, but dep on 4
12. same as 5, but dep on 10
13. same as 6, but dep on 10
14. same as 10, but dep on 4
15. same as 6, but dep on 5
16. same as 6, but dep on 12
17. same as 7, but change "source" to -- sink --
18. same as 7, but dep on 4
19. same as 17, but dep on 4
20. same as 7, but dep on 5

Abstract

Method for implicitly projecting communications links

~~The invention relates to a~~ ⁹¹ ~~method for~~ ^{pro. 182. 13} implicitly projecting communications links. The projection of the communications links is carried out ~~in the following~~ ^{four steps:}

- interconnecting the automation objects, and
- setting the quality of service (QoS) of the communications relationships.
- ^{Thereafter} assigning the automation objects ^{are assigned} to equipment units, ^{for each} function.
- downloading the automation solution ^{is downloaded} into the system.

09/936046

SUBSTITUTE SPECIFICATION

METHOD FOR IMPLICITLY PROJECTING COMMUNICATIONS LINKS

[0001] This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/DE00/00733 which has an International filing date of March 9, 2000, which designated the United States of America, the entire contents of which are hereby incorporated by reference.

Field of the Invention

[0002] The invention relates to a method for implicitly projecting communications links.

Background of the Invention

[0003] Such a method is used in particular in the field of automation technology. An automation solution is generally composed of a multiplicity of individual automation objects which frequently have a high degree of dependency of the automation object on the respectively used engineering system. The result of this is that automation objects of a manufacturer frequently require a specific engineering system and cannot be used in other systems with automation objects of other manufacturers.

[0004] The specialist articles Zinky, J. A. et al: "Architectural Support for Quality of Service for CORBA Objects", Theory and Practice of Object Systems, (Online) Vol. 3, No. 1, 1997, pages 55-73, XP000961779, Wiley, USA, ISSN: 1074-3227 describes a system architecture (Quality of Service) for CORBA objects. The described architecture was developed in particular with the objective of simplifying the implementation of and use of objects distributed in a long-distance traffic network.

SUMMARY OF THE INVENTION

[0005] The invention is based on an object of permitting communications links to be projected within automation solutions, in particular without restriction to boundaries between equipment units.

[0006] This and/or other objects are achieved by means of a method having the features disclosed in claim 1.

[0007] The invention is based on the knowledge that previous solutions have a series of disadvantages. The automation objects used in creating the automation solution have inputs and outputs via which they can communicate with other automation objects. These inputs and

outputs are used to determine, at the projection time, which communication has to take place at the run time of the automation solution.

[0008] In existing projection systems, the projection of the communication takes place per equipment unit. Within one equipment unit, communication relationships between the automation solution.

[0009] In existing projection systems, the projection of the communication takes place per equipment unit. Within one equipment unit, communication relationships between the automation objects of the equipment unit are established by what is referred to as interconnections. An interconnection connects an output of an automation object to an input of an automation object in the engineering process and thus determines the communication which takes place at the run time. If communication between equipment units is necessary, it must be projected by means of special communication modules.

[0010] This solution has the following disadvantages:

- **explicit projection of the communication:** communication between equipment units must be explicitly projected. To do this, suitable communication modules must be selected. These must then be appropriately parameterized and interconnected with the actual automation objects.
- **determination of the equipment units before the automation solution is created:** before the development of the automation solution can be started, it is firstly necessary to determine which equipment units will later run the projected solution. Only then can the development of the solution be started, in each case on one equipment unit.
- **costly change to the assignment of equipment units:** if an equipment unit is selected, the automation objects which are projected onto it cannot be readily transferred to another equipment unit.
- **determination of the communication protocols:** the use of specific communications modules automatically imposes a restriction to the specific communication protocols.

[0011] In the solution according to the invention, the automation solution in the engineering process is composed successively by the use of automation objects. The automation objects are a number of modules which have a specific functionality. The automation objects have inputs and outputs which can be used to predetermine values for the calculations or the result of the calculations can be picked up.

[0012] The automation solution is actually created by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the

communication which takes place on the system during the run time. The communication can have any desired content. It can comprise, for example, data or events. In the following image, the indications between the inputs and outputs of the automation objects AO1, AO2, AO3 and AO4 are represented by lines.

[0013] An interconnection is an independent object which unambiguously determines a communication relationship between two automation objects. To do this, a reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not bring about any changes in the interconnected automation objects.

[0014] Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit and intra-equipment unit communication is eliminated here.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention is described and explained in more detail below with reference to the exemplary embodiments illustrated in the figures, in which

- Figure 1 shows a basic diagram of a projection by means of interconnections,
- Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)",
- Figure 3 shows an exemplary embodiment of an assignment of automation objects to equipment units, and
- Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Figure 1 shows a basic diagram of a projection by means of interconnections. In the engineering process, the automation solution is composed successively by using automation objects. The automation objects are a type of module which have a specific functionality. The automation objects have inputs and outputs which can be used to predefine values for the calculations and/or to pick up the result of the calculations.

[0017] The actual creation of the automation solution is carried out by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the communication which takes place for the run time on the system. The

communication can have any desired content. It can comprise, for example, data or events. In the following image, the interconnections between the inputs and outputs of the automation objects AO1, AO2, AO3 and AO4 are represented by lines.

[0018] An interconnection is an independent object which unambiguously defines a communication relationship between two automation objects. To do this, the reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not result in any changes in the interconnected automation objects. Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit and intra-equipment unit communication is eliminated here.

[0019] Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)". The quality of service of the communications relationship can be additionally set for the established interconnections. One example is the setting of the cycle time with which changes are checked at the data source. If the cycle time is relatively long, this means that relatively little communication takes place between the automation objects. For this reason, distribution among various equipment units is rather uncritical because the generated network load is low.

[0020] A cycle time of 20 milliseconds is set for the interconnection between automation objects AO2 and AO3 in Figure 2.

[0021] Figure 3 shows an exemplary embodiment of an assignment of the automation objects to equipment units. After the automation solution has been created, the automation objects are assigned to equipment units. The equipment units are representatives of real equipment units of the system (such as memory-programmable controllers or drives) in the projection environment. The projection of the equipment units and of the associated networks is carried out separately. The representatives of the equipment units in the projection environment satisfy here a uniform equipment unit model and thus form an abstraction of the real equipment units.

[0022] For each automation, object it is then determined which equipment unit the automation object will later be executed on in the system. In a graphic editor, this can be implemented by means of drag and drop, for example. Which interconnections represent intra-equipment unit communication and which represent communication which is internal to an equipment unit, is only determined as a result of the assignment. In Figure 3, the result of the assignment of the automation objects AO1 and AO2 to G1 and AO3 and AO4 to G2 is

that the communication between AO1 and AO2 and also between AO3 and AO4 is internal to an equipment unit, while the communication between AO1 and AO3 and as well as between AO2 and AO4 is intra-equipment unit communication.

[0023] In an effective implementation of the assignment, the data of the equipment units (and networks) and of the respective predefined quality of services can be used in order to carry out a first plausibility check of the respective real-time requirements made of the automation solution.

[0024] Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system. The automation solution which has so far been projected is downloaded into the real system in the last step. This procedure is designated as a download. The download is initiated from the projection environment and is carried out for each equipment unit, to be more precise the representatives of the equipment unit, in the production environment. Each equipment-unit representative knows its real counterpart in the system and can communicate with it via the communication link of the projection environment to the system.

[0025] In the first step, the automation objects assigned to each equipment-unit representative are generated for the representatives of the corresponding counterparts in the physical equipment unit. In the case of a freely programmable equipment unit, this means that a corresponding piece of code is downloaded into the equipment unit. For an equipment unit with a fixed functionality, the corresponding run time counterpart of the automation object in the physical equipment unit is identified.

[0026] In the second step, the communications relationships described by the interconnections are established. Here, the addressing of the source and sink of a communications relationship is expanded with corresponding identifiers of the inputs and outputs of the run time automation objects. Such an identifier is composed of the identifiers of the physical equipment unit, of the run time automation object and of the input and output. A common equipment unit model of the run time environment is necessary for this. Each equipment unit representative then communicates to its physical counterpart via the enhanced interconnections of its automation objects.

[0027] On the basis of the interconnection information, each equipment unit then establishes its internal and external communications relationships. The enhanced information of the interconnections is used to do this. In an efficient implementation, use can be made of the fact that each equipment unit has to establish only the communications relationships in which it functions as a source (or alternatively as a sink).

[0028] In our example, the automation objects AO1 and AO2 are established on the equipment unit physical RG1 as run time automation objects RAO1 and RAO2 and AO3 and AO4 on the equipment unit RG2 as RAO3 and RAO4. The interconnection information is then enhanced, as described, with corresponding information on the run time environment. For the communications relationship between AO1 and AO3, this information comprises the identifiers of RG1, RAO1, of the output of RAO1 for the source and RG2, RAO3, and the input of RAO3 for the sink. This information can then be used to set up the corresponding communications relationship between RAO1 on the equipment unit RG1 and RAO3 on the equipment unit RG2.

[0029] The development of the automation functionality is dissociated from the automation equipment units to be used. As a result, a distinction is no longer made between the projection of communication between automation objects within an equipment unit and projection onto different equipment units. In the case of intra-equipment unit communication, it is necessary to ensure here that the real-time requirements of the application are complied with.

[0030] Communications relationships between automation objects are projected uniformly by means of interconnections. The interconnections can be assigned a specific quality of service by means of which specific properties which are to be fulfilled can be determined for the communications relationship. In particular, in the case of an intra-equipment unit communications relationship, the quality of service can be used in order to test whether the communications relationship can be set up (and ensured) by the equipment units in question.

[0031] This approach provides, but is not limited to, the following advantages:

- **uniform projection by means of interconnection:** the projection of the communication between automation objects is carried out in a uniform fashion. The case of intra-equipment unit communication no longer has to be handled separately. Furthermore, the projection can take place independently of the communication content (for example data or events).
- **less outlay on projection:** in the case of intra-equipment unit projection, the use and projection of special communications modules is eliminated.
- **more flexible assignment of equipment units:** automation objects can now be assigned to an equipment unit at any time, and/or the assignment can easily be changed.
- **ease of change:** the explicit procedure of assigning automation objects to equipment units simplifies the use of other target systems/bus systems significantly.

[0032] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

09/936046

Description

JC12 Rec'd PCT/PTO 07 SEP 2001

Method for implicitly projecting communications links

- 5 The invention relates to a method for implicitly projecting communications links.

Such a method is used in particular in the field of automation technology. An automation solution is generally composed of a multiplicity of individual automation objects which frequently have a high degree of dependency of the automation object on the respectively used engineering system. The result of this is that automation objects of a manufacturer frequently require a specific engineering system and cannot be used in other systems with automation objects of other manufacturers.

The specialist articles Zinky, J. A. et al: "Architectural Support for Quality of Service for CORBA Objects", Theory and Practice of Object Systems, (Online) Vol. 3, No. 1, 1997, pages 55-73, XP000961779, Wiley, USA, ISSN: 1074-3227 describes a system architecture (Quality of Service) for CORBA objects. The described architecture was developed in particular with the objective of simplifying the implementation of and use of objects distributed in a long-distance traffic network.

30 The invention is based on the object of permitting communications links to be projected within automation solutions in particular without restriction to boundaries between equipment units.

35 This object is achieved by means of a method having the features disclosed in claim 1.

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The invention is based on the knowledge that previous solutions have a series of disadvantages. The automation objects used in creating the automation solution have inputs and outputs via which they can communicate with other automation objects. These inputs and outputs are used to determine, at the projection time, which communication has to take place at the run time of the automation solution.

- 5
- 10 In existing projection systems, the projection of the communication takes place per equipment unit. Within one equipment unit, communication relationships between the automation

objects of the equipment unit are established by what is referred to as interconnections. An interconnection connects an output of an automation object to an input of an automation object in the engineering process and thus determines the communication which takes place at the run time. If communication between equipment units is necessary, it must be projected by means of special communication modules.

This solution has the following disadvantages:

- 10 § **explicit projection of the communication:**
communication between equipment units must be explicitly projected. To do this, suitable communication modules must be selected. These must then be appropriately parameterized and
- 15 interconnected with the actual automation objects.
- § **determination of the equipment units before the automation solution is created:** before the development of the automation solution can be started, it is firstly necessary to determine which equipment units
- 20 will later run the projected solution. Only then can the development of the solution be started, in each case on one equipment unit.
- § **costly change to the assignment of equipment units:** if an equipment unit is selected, the automation
- 25 objects which are projected onto it cannot be readily transferred to another equipment unit.
- § **determination of the communication protocols:** the use of specific communications modules automatically imposes a restriction to the specific communication
- 30 protocols.

In the solution according to the invention, the automation solution in the engineering process is composed successively by the use of automation objects.

- 35 The automation objects are a number of modules which have a specific functionality. The automation objects have inputs and outputs which can be used to predetermine values for the calculations or the result of the calculations can be picked up.

The automation solution is actually created by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the communication which takes place on the system during the run time. The communication can have any desired content. It can comprise, for example, data or events. In the following image, the indications between the inputs and outputs of the automation objects A01, A02, A03 and A04 are represented by lines.

An interconnection is an independent object which unambiguously determines a communication relationship between two automation objects. To do this, a reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not bring about any changes in the interconnected automation objects.

Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit and intra-equipment unit communication is eliminated here.

The invention is described and explained in more detail below with reference to the exemplary embodiments illustrated in the figures, in which

Figure 1 shows a basic diagram of a projection by means of interconnections,

Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)",

Figure 3 shows an exemplary embodiment of an assignment of automation objects to equipment units, and

Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system.

Figure 1 shows a basic diagram of a projection by means of interconnections. In the engineering process, the automation solution is composed successively by using automation objects. The automation objects are a type of module which have a specific functionality. The automation objects have inputs and outputs which can be used to predefine values for the calculations and/or to pick up the result of the calculations.

The actual creation of the automation solution is carried out by interconnecting the corresponding inputs and outputs of the automation objects. These interconnections then determine the communication which takes place for the run time on the system. The communication can have any desired content. It can comprise, for example, data or events. In the following image, the interconnections between the inputs and outputs of the automation objects A01, A02, A03 and A04 are represented by lines.

An interconnection is an independent object which unambiguously defines a communication relationship between two automation objects. To do this, the reference to the corresponding output of an automation module is administered for the data source, and a reference to the corresponding input of an automation module is administered for the data sink. The interconnection objects are also independent of the automation objects, which is manifest in the fact that the setting up of an interconnection does not result in any changes in the interconnected automation objects. Because the automation objects in this step are independent of equipment units, the distinction between communication which is internal to an equipment unit

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and intra-equipment unit communication is eliminated here.

Figure 2 shows a schematic diagram of a projection of what is referred to as "Quality of Service (QoS)". The quality of service of the communications relationship can be additionally set for the established
5 interconnections. One example is the setting of the cycle time with which changes are checked at the data source. If the cycle time is relatively long, this means that relatively little communication takes place between the automation objects. For this reason,
10 distribution among various equipment units is rather uncritical because the generated network load is low.

A cycle time of 20 milliseconds is set for the interconnection between automation objects AO2 and AO3
15 in Figure 2.

Figure 3 shows an exemplary embodiment of an assignment of the automation objects to equipment units. After the automation solution has been created, the automation
20 objects are assigned to equipment units. The equipment units are representatives of real equipment units of the system (such as memory-programmable controllers or drives) in the projection environment. The projection of the equipment units and of the associated networks
25 is carried out separately. The representatives of the equipment units in the projection environment satisfy here a uniform equipment unit model and thus form an abstraction of the real equipment units.

30 For each automation object it is then determined which equipment unit the automation object will later be executed on in the system. In a graphic editor, this can be implemented by means of drag and drop, for example. Which interconnections represent intra-
35 equipment unit communication and which represent communication which is internal to an equipment unit is only determined as a result of the assignment. In Figure 3, the result of the assignment of the automation objects AO1 and AO2 to G1 and AO3 and AO4 to

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G2 is that the communication between A01 and A02 and also between A03 and A04 is internal to an equipment unit, while the

communication between AO1 and AO3 and as well as between AO2 and AO4 is intra-equipment unit communication.

5 In an effective implementation of the assignment, the data of the equipment units (and networks) and of the respective predefined quality of services can be used in order to carry out a first plausibility check of the respective real-time requirements made of the
10 automation solution.

Figure 4 shows an exemplary diagram of the downloading of an automation solution into an automation system. The automation solution which has so far been projected
15 is downloaded into the real system in the last step. This procedure is designated as a download. The download is initiated from the projection environment and is carried out for each equipment unit, to be more precise the representatives of the equipment unit, in
20 the production environment. Each equipment-unit representative knows its real counterpart in the system and can communicate with it via the communication link of the projection environment to the system. In the first step, the automation objects assigned to each
25 equipment-unit representative are generated for said representatives [lacuna] the corresponding counterparts in the physical equipment unit. In the case of a freely programmable equipment unit, this means that a corresponding piece of code is downloaded into the
30 equipment unit. For an equipment unit with a fixed functionality, the corresponding run time counterpart of the automation object in the physical equipment unit is identified. In the second step, the communications relationships described by the interconnections are
35 established. Here, the addressing of the source and sink of a communications relationship is expanded with corresponding identifiers of the inputs and outputs of the run time automation objects. Such an identifier is composed of the identifiers of the physical equipment

unit, of the run time automation object and of the
input and output. A common equipment unit model of the
run time environment is necessary for this. Each
equipment unit representative then communicates to its
5 physical counterpart the enhanced interconnections

of its automation objects. On the basis of the interconnection information, each equipment unit then establishes its internal and external communications relationships. The enhanced information of the interconnections is used to do this. In an efficient implementation, use can be made of the fact that each equipment unit has to establish only the communications relationships in which it functions as a source (or alternatively as a sink).

10 In our example, the automation objects AO1 and AO2 are established on the equipment unit physical RG1 as run time automation objects RAO1 and RAO2 and AO3 and AO4 on the equipment unit RG2 as RAO3 and RAO4. The interconnection information is then enhanced, as
15 described, with corresponding information on the run time environment. For the communications relationship between AO1 and AO3, this information comprises the identifiers of RG1, RAO1, of the output of RAO1 for the source and RG2, RAO3, and the input of RAO3 for the
20 sink. This information can then be used to set up the corresponding communications relationship between RAO1 on the equipment unit RG1 and RAO3 on the equipment unit RG2.

25 The development of the automation functionality is dissociated from the automation equipment units to be used. As a result, a distinction is no longer made between the projection of communication between automation objects within an equipment unit and
30 projection onto different equipment units. In the case of intra-equipment unit communication, it is necessary to ensure here that the real-time requirements of the application are complied with. Communications relationships between automation objects are projected
35 uniformly by means of interconnections. The interconnections can be assigned a specific quality of service by means of which specific properties which are to be fulfilled can be determined for the communications relationship. In particular, in the case

項目	単位	1990年	1991年	1992年	1993年	1994年	1995年	1996年	1997年	1998年	1999年	2000年	2001年	2002年	2003年	2004年	2005年	2006年	2007年	2008年	2009年	2010年	2011年	2012年	2013年	2014年	2015年	2016年	2017年	2018年	2019年	2020年	2021年	2022年	2023年	2024年	2025年	2026年	2027年	2028年	2029年	2030年	2031年	2032年	2033年	2034年	2035年	2036年	2037年	2038年	2039年	2040年	2041年	2042年	2043年	2044年	2045年	2046年	2047年	2048年	2049年	2050年	2051年	2052年	2053年	2054年	2055年	2056年	2057年	2058年	2059年	2060年	2061年	2062年	2063年	2064年	2065年	2066年	2067年	2068年	2069年	2070年	2071年	2072年	2073年	2074年	2075年	2076年	2077年	2078年	2079年	2080年	2081年	2082年	2083年	2084年	2085年	2086年	2087年	2088年	2089年	2090年	2091年	2092年	2093年	2094年	2095年	2096年	2097年	2098年	2099年	2100年																																																																		
総人口	人	12,100,000	12,200,000	12,300,000	12,400,000	12,500,000	12,600,000	12,700,000	12,800,000	12,900,000	13,000,000	13,100,000	13,200,000	13,300,000	13,400,000	13,500,000	13,600,000	13,700,000	13,800,000	13,900,000	14,000,000	14,100,000	14,200,000	14,300,000	14,400,000	14,500,000	14,600,000	14,700,000	14,800,000	14,900,000	15,000,000	15,100,000	15,200,000	15,300,000	15,400,000	15,500,000	15,600,000	15,700,000	15,800,000	15,900,000	16,000,000	16,100,000	16,200,000	16,300,000	16,400,000	16,500,000	16,600,000	16,700,000	16,800,000	16,900,000	17,000,000	17,100,000	17,200,000	17,300,000	17,400,000	17,500,000	17,600,000	17,700,000	17,800,000	17,900,000	18,000,000	18,100,000	18,200,000	18,300,000	18,400,000	18,500,000	18,600,000	18,700,000	18,800,000	18,900,000	19,000,000	19,100,000	19,200,000	19,300,000	19,400,000	19,500,000	19,600,000	19,700,000	19,800,000	19,900,000	20,000,000	20,100,000	20,200,000	20,300,000	20,400,000	20,500,000	20,600,000	20,700,000	20,800,000	20,900,000	21,000,000	21,100,000	21,200,000	21,300,000	21,400,000	21,500,000	21,600,000	21,700,000	21,800,000	21,900,000	22,000,000	22,100,000	22,200,000	22,300,000	22,400,000	22,500,000	22,600,000	22,700,000	22,800,000	22,900,000	23,000,000	23,100,000	23,200,000	23,300,000	23,400,000	23,500,000	23,600,000	23,700,000	23,800,000	23,900,000	24,000,000	24,100,000	24,200,000	24,300,000	24,400,000	24,500,000	24,600,000	24,700,000	24,800,000	24,900,000	25,000,000	25,100,000	25,200,000	25,300,000	25,400,000	25,500,000	25,600,000	25,700,000	25,800,000	25,900,000	26,000,000	26,100,000	26,200,000	26,300,000	26,400,000	26,500,000	26,600,000	26,700,000	26,800,000	26,900,000	27,000,000	27,100,000	27,200,000	27,300,000	27,400,000	27,500,000	27,600,000	27,700,000	27,800,000	27,900,000	28,000,000	28,100,000	28,200,000	28,300,000	28,400,000	28,500,000	28,600,000	28,700,000	28,800,000	28,900,000	29,000,000	29,100,000	29,200,000	29,300,000	29,400,000	29,500,000	29,600,000	29

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of an intra-equipment unit communications relationship, the quality of service can be used in order to test whether the communications relationship

can be set up (and ensured) by the equipment units in question.

This approach provides the following advantages:

- 5 § **uniform projection by means of interconnection:** the projection of the communication between automation objects is carried out in a uniform fashion. The case of intra-equipment unit communication no longer has to be handled separately. Furthermore, the projection can take place independently of the communication content (for example data or events).
- 10 § **less outlay on projection:** in the case of intra-equipment unit projection, the use and projection of special communications modules is eliminated.
- 15 § **more flexible assignment of equipment units:** automation objects can now be assigned to an equipment unit at any time, and/or the assignment can easily be changed.
- 20 § **ease of change:** the explicit procedure of assigning automation objects to equipment units simplifies the use of other target systems/bus systems significantly.

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Patent claims

1. A method for projecting communications relationships within automation solutions, in particular without
5 restriction to boundaries between equipment units, in which

- an automation solution is composed using an engineering system by using automation objects (AO1, AO2, AO3, AO4),

10 - in each case one interconnection connects an output of an automation object (AO1, AO2, AO3, AO4) to an input of an another automation object (AO1, AO2, AO3, AO4), the interconnection for a data source administering a reference to the corresponding
15 output of an automation module (AO1, AO2, AO3, AO4), and a reference to the corresponding input of an automation module (AO1, AO2, AO3, AO4) for a data sink, and

- after the creation of the automation solution, the
20 automation objects (AO1, AO2, AO3, AO4) are assigned to physical equipment units (RG1, RG2) of a real system, and which interconnections represent intra-equipment unit communications relationships and which represent communications relationships within
25 an equipment unit is only determined as a result of the assignment.

2. The method as claimed in claim 1,
characterized in that the interconnections can be
30 assigned a quality of service by means of which specific properties which are to be fulfilled can be defined for the communications relationships.

3. The method as claimed in claim 1 or 2,
35 characterized in that the projected automated solution is downloaded by means of a download into the real system by means of a download, the download being

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carried out for each equipment-unit representative (G1,
G2) in the projection environment, and each

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equipment-unit representative (G1, G2) being able to communicate with the physical equipment unit (RG1, RG2) in the system via a communications link.

5 4. The method as claimed in claim 3,
wherein, in the first step of the download, the
corresponding run time automation objects (RAO1, RAO2,
RAO3, RAO4) in the physical equipment unit (RG1, RG2)
are generated for each equipment-unit representative
10 (G1, G2) for the automation objects (AO1, AO2, AO3,
AO4) which are assigned to it, and the communications
links described by the interconnections are established
in the second step.

15 5. The method as claimed in claim 3 or 4,
characterized in that the interconnections are enhanced
with information relating to the real system,
addressing of the source and sink of a communications
relationship being expanded with identifiers
20 - of the physical equipment unit (RG1, RG2),
- of the run time automation objects (RAO1, RAO2,
RAO3, RAO4) and
- of the inputs and outputs of the run time automation
objects (RAO1, RAO2, RAO3, RAO4).

25 6. The method as claimed in one of claims 3 to 5,
characterized in that each equipment-unit
representative (G1, G2) communicates to its physical
counterpart (RG1, RG2) the enhanced interconnections of
30 its automation objects (AO1, AO2, AO3, AO4) and each
equipment unit (RG1, RG2) establishes its internal and
external communications relationships on the basis of
the interconnection information.

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7. The method as claimed in one of claims 3 to 6,
characterized in that each equipment unit (G1, G2)
establishes only the communications relationships in
which it functions as a source (or alternatively as a
5 sink).

8. The method as claimed in one of the preceding
claims,
characterized in that the setting up of an
10 interconnection does not cause any changes in the
automation objects (AO1, AO2, AO3, AO4).

9. The method as claimed in one of the preceding
claims,
15 characterized in that the equipment-unit
representatives (G1, G2) in the projection environment
satisfy a uniform equipment unit model and form an
abstraction of the real equipment units (RG1, RG2).

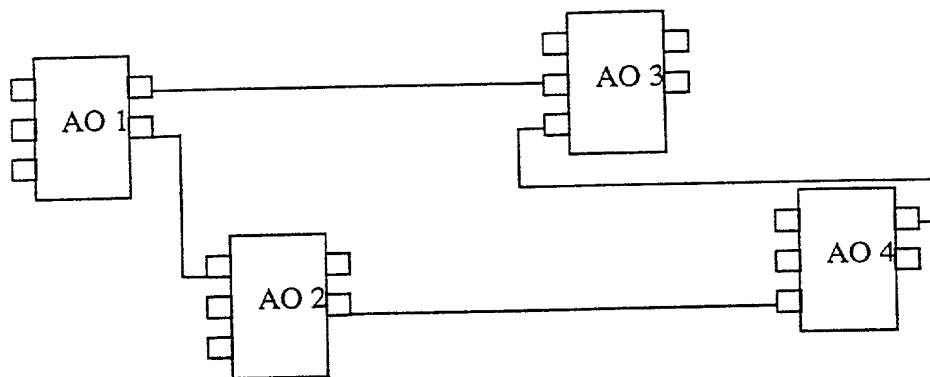


Fig. 1

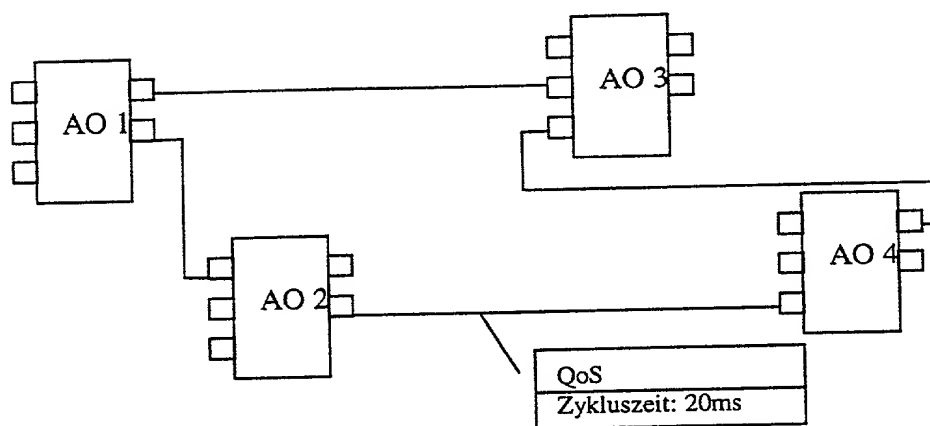
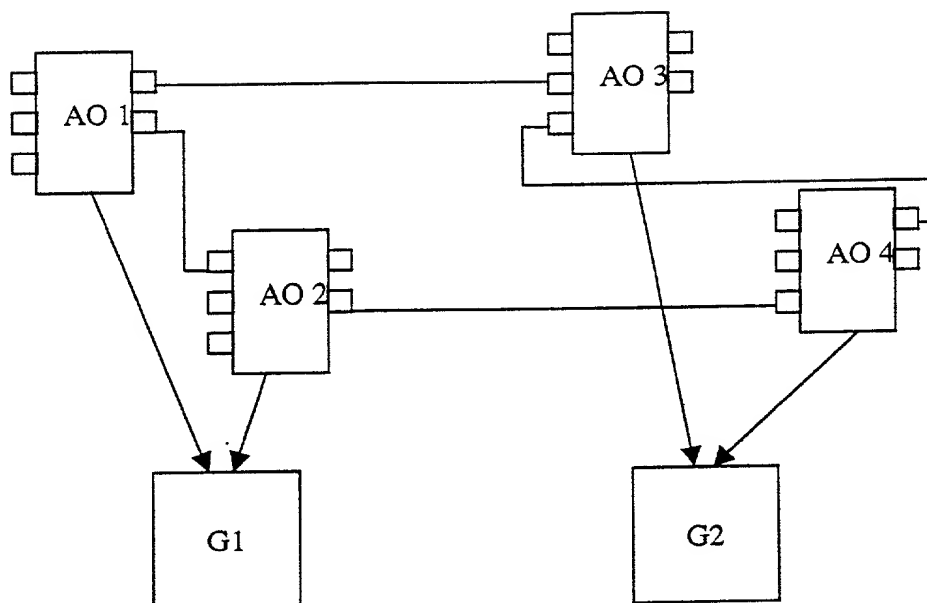


Fig. 2

09/936046

**Fig. 3**

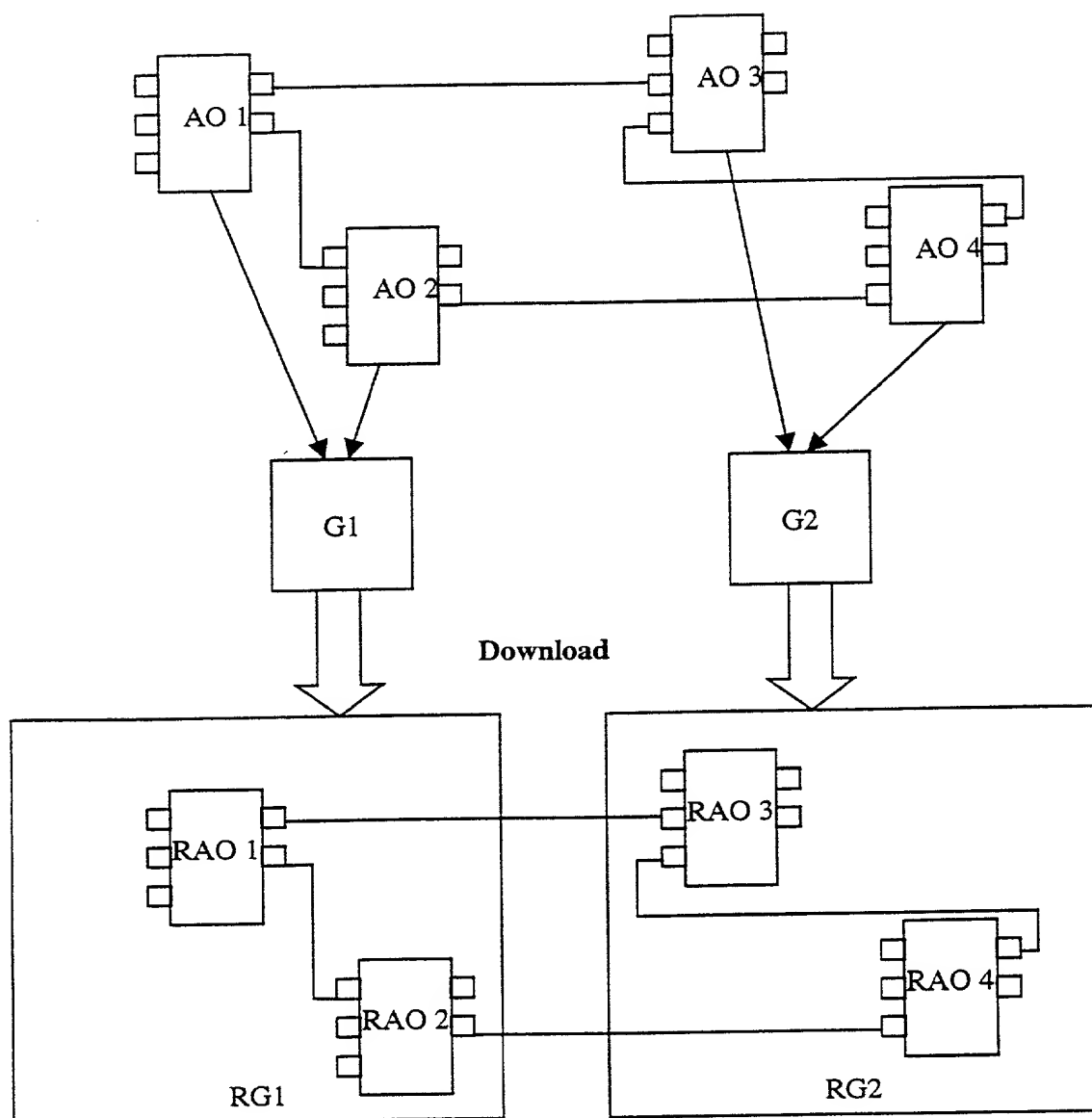


Fig. 4



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IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicants: Norbert BECKER et al.

Int'l Application No.: PCT/DE00/00733

Application No.: 09/936,046

Filed: September 7, 2001

For: METHOD FOR IMPLICITLY CONFIGURING
COMMUNICATIONS LINKS

**CHANGE OF ADDRESS AND REVOCATION AND
SUBSTITUTION OF POWER OF ATTORNEY**

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

January 2, 2002

Sir:

Under 37 C.F.R. § 3.73(b), the undersigned hereby states that the below-named Assignee is
an assignee in the above-identified Application:

Assignee: **SIEMENS AKTIENGESELLSCHAFT**

The documentary evidence of a chain of title from the original owner to the Assignee is
provided in the Assignment Document(s):

- ☒ filed herewith,
☐ previously filed,

Reel No. _____, Frame No. _____.

I hereby declare that all statements made herein of my own knowledge are true, and that all
statements made on information and belief are believed to be true; and further that these statements
are made with the knowledge that willful false statements, and the like so made, are punishable by
fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such
willful false statements may jeopardize the validity of the application or any patent issuing thereon.

POWER OF ATTORNEY

The Declaration submitted along with this application includes a Power of Attorney listing the attorneys of Birch, Stewart, Kolasch & Birch, LLP. Please hereby revoke the aforementioned attorneys and substitute the attorneys of Customer No. 30596, including the following attorneys of Harness, Dickey & Pierce, P.L.C., to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Terry L. Clark	Registration No. 32,644
Donald J. Daley	Registration No. 34,313
John A. Castellano	Registration No. 35,094
Gary D. Yacura	Registration No. 35,416
Thomas S. Auchterlonie	Registration No. 37,275
Timothy R. Wyckoff	Registration No. 46,175

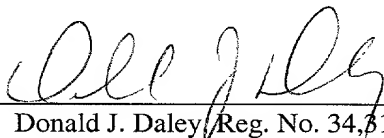
CORRESPONDENCE ADDRESS

I request the Patent and Trademark Office to direct all correspondence and telephone calls relative to this application to Customer No. 30596, Harness, Dickey & Pierce, P.L.C., P.O. Box 8910, Reston, Virginia 20195, (703) 390-3030.

The undersigned is empowered with full Power of Attorney on behalf of the assignee.

Respectfully submitted,

HARNESS, DICKEY & PIERCE, P.L.C

By: 
Donald J. Daley, Reg. No. 34,313

DJD:kna

P.O. Box 8910
Reston, Virginia 20195
(703) 390-3030

Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren zur impliziten Projektierung von Kommunikationsverbindungen

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am 09.03.2000 als

PCT internationale Anmeldung

PCT Anwendungsnummer PCT/DE00/00733

eingereicht wurde und am abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method for implicitly configuring communications links

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 09.03.2000 as

PCT international application

PCT Application No. PCT/DE00/00733

and was amended on (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19910544.8

DE

09.03.1999

☒

☐

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Yes
Ja

No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/00733

(Application Serial No.)
(Anmeldeseriennummer)

09.03.2000

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

(Status)

(patentiert, anhängig,
aufgegeben)

pending

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D,M,Y)
(Anmeldedatum T, M; J)

(Status)

(patentiert, anhängig,
aufgeben)

(Status)

(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Customer No. 02292

And I hereby appoint

Telefongespräche bitte richten an:
(Name und Telefonnummer)

Direct Telephone Calls to: (name and telephone number)

Ext. _____

Postanschrift:

Send Correspondence to:

Birch, Stewart, Kolasch & Birch, LLP
8110 Gatehouse Road / Suite 500 East 22042 Falls Church, Virginia
Telephone: +1 703 205 8000 and Facsimile +1 703 205 8050
or
Customer No. 02292

Voller Name des einzigen oder ursprünglichen Erfinders: NORBERT BECKER 1-00		Full name of sole or first inventor: NORBERT BECKER	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
		<i>Norbert Becker</i>	22.8.2001
Wohnsitz ERLANGEN, DEUTSCHLAND		Residence ERLANGEN, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift TURMHÜGELWEG 20A		Post Office Address TURMHÜGELWEG 20A	
91058 ERLANGEN		91058 ERLANGEN	
DEUTSCHLAND		GERMANY	
Voller Name des zweiten Miterfinders (falls zutreffend): GEORG BIEHLER 2-00		Full name of second joint inventor, if any: GEORG BIEHLER	
Unterschrift des Erfinders	Datum	Second inventor's signature	Date
		<i>Georg Biehler</i>	22.8.2001
Wohnsitz NÜRNBERG, DEUTSCHLAND		Residence NÜRNBERG, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift SCHALKHAUSSER STR. 102A		Post Office Address SCHALKHAUSSER STR. 102A	
90473 NÜRNBERG		90473 NÜRNBERG	
DEUTSCHLAND		GERMANY	

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Voller Name des dritten Miterfinders: MATTHIAS DIEZEL 3-00		Full name of third joint inventor: MATTHIAS DIEZEL	
Unterschrift des Erfinders	Datum	Inventor's signature <i>Matthias Diezel</i>	Date 10.9.01
Wohnsitz LAUFAMHOLZ, DEUTSCHLAND		Residence LAUFAMHOLZ, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift GLÄSLEINSACKERWEG 25		Post Office Address GLÄSLEINSACKERWEG 25	
90482 LAUFAMHOLZ DEUTSCHLAND		90482 LAUFAMHOLZ GERMANY	
Voller Name des vierten Miterfinders: Dr. ALBRECHT DONNER 4-00		Full name of fourth joint inventor: Dr. ALBRECHT DONNER	
Unterschrift des Erfinders	Datum	Inventor's signature <i>Albrecht Donner</i>	Date 20.9.01
Wohnsitz MARKERSDORF, DEUTSCHLAND		Residence MARKERSDORE, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift HAUPTSTR.92		Post Office Address HAUPTSTR.92	
09236 MARKERSDORF DEUTSCHLAND		09236 MARKERSDORF GERMANY	
Voller Name des fünften Miterfinders: Dr. DIETER ECKARDT 5-00		Full name of fifth joint inventor: Dr. DIETER ECKARDT	
Unterschrift des Erfinders	Datum	Inventor's signature <i>Dieter Eckardt</i>	Date 18.09.2001
Wohnsitz HERZOGENAURACH, DEUTSCHLAND		Residence HERZOGENAURACH, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift ZIEHRER STR 8		Post Office Address ZIEHRER STR 8	
91074 HERZOGENAURACH DEUTSCHLAND		91074 HERZOGENAURACH GERMANY	
Voller Name des sechsten Miterfinders: MANFRED KRÄMER 6-00		Full name of sixth joint inventor: MANFRED KRÄMER	
Unterschrift des Erfinders	Datum	Inventor's signature <i>Manfred Krämer</i>	Date 02.10.01
Wohnsitz WENDELSTEIN, DEUTSCHLAND		Residence WENDELSTEIN, GERMANY DEX	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift FLIEDERWEG 21A		Post Office Address FLIEDERWEG 21A	
90530 WENDELSTEIN DEUTSCHLAND		90530 WENDELSTEIN GERMANY	

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Voller Name des siebten Miterfinders: DIRK LANGKAFEL		Full name of seventh joint inventor: DIRK LANGKAFEL	
Unterschrift des Erfinders	Datum 7-00	Inventor's signature <i>Dirk Langkafel</i>	Date 12.09.01
Wohnsitz EFFELTRICH, DEUTSCHLAND		Residence EFFELTRICH, GERMANY <i>DEX</i>	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift BERGSTR. 15A		Post Office Address BERGSTR. 15A	
91090 EFFELTRICH DEUTSCHLAND		91090 EFFELTRICH GERMANY	
Voller Name des achten Miterfinders (falls zutreffend): RALF LEINS		Full name of eighth joint inventor, if any: RALF LEINS	
Unterschrift des Erfinders	Datum 8-00	Inventor's signature <i>Ralf Leins</i>	Date 22.8.01
Wohnsitz ISPRINGEN, DEUTSCHLAND		Residence ISPRINGEN, GERMANY <i>DEX</i>	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift IM MAHLER 38		Post Office Address IM MAHLER 38	
75228 ISPRINGEN DEUTSCHLAND		75228 ISPRINGEN GERMANY	
Voller Name des neunten Miterfinders (falls zutreffend): RONALD LANGE		Full name of ninth joint inventor, if any: RONALD LANGE	
Unterschrift des Erfinders	Datum 9-00	Inventor's signature <i>Ronald Lange</i>	Date 8/23/01
Wohnsitz FÜRTH, DEUTSCHLAND		Residence FÜRTH, GERMANY <i>DEX</i>	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift VIRCHOWSTR. 28		Post Office Address VIRCHOWSTR. 28	
90766 FÜRTH DEUTSCHLAND		90766 FÜRTH GERMANY	
Voller Name des zehnten Miterfinders (falls zutreffend): KARSTEN SCHNEIDER		Full name of tenth joint inventor, if any: KARSTEN SCHNEIDER	
Unterschrift des Erfinders	Datum 10-00	Inventor's signature <i>K. Schneider</i>	Date 11.09.01
Wohnsitz ERLANGEN, DEUTSCHLAND		Residence ERLANGEN, GERMANY <i>DEX</i>	
Staatsangehörigkeit DEUTSCH		Citizenship GERMAN	
Postanschrift BOHLENPLATZ 7		Post Office Address BOHLENPLATZ 7	
91054 ERLANGEN DEUTSCHLAND		91054 ERLANGEN GERMANY	

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(Supply similar information and signature for third and subsequent joint inventors).

Voller Name des elften Miterfinders:		Full name of eleventh joint inventor:	
HELMUT WINDL		HELMUT WINDL	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
		<i>H. Windl</i>	8/29/2001
Wohnsitz		Residence	
PEISIG, DEUTSCHLAND		PEISIG, GERMANY DEX	
Staatsangehörigkeit		Citizenship	
DEUTSCH		GERMAN	
Postanschrift		Post Office Address	
FÖHRENSTR.10		FÖHRENSTR.10	
93077 PEISIG		93077 PEISIG	
DEUTSCHLAND		GERMANY	

Voller Name des zwölften Miterfinders (falls zutreffend):		Full name of twelfth joint inventor, if any:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

Voller Name des dreizehnten Miterfinders (falls zutreffend):		Full name of thirteenth joint inventor, if any:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

Voller Name des vierzehnten Miterfinders (falls zutreffend):		Full name of fourteenth joint inventor, if any:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

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(Supply similar information and signature for third and subsequent joint inventors).